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(54) Device for stabilization of the paper web in a group of cylinders in the drying section of a paper machine.

(57) The invention concerns a device (20) for stabilization of the paper web in a group of cylinders in the dryer section of a paper machine, which group of cylinders comprises a row of drying cylinders (10) and a corresponding row of leading rolls (12) or equivalent placed as interlocked with said drying cylinders, said group of cylinders being provided with single-wire draw (11) so that the heated drying cylinders (10) in the group are placed outside their loop of the drying wire (11) and the leading rolls (12) in the group are placed inside the loop of the drying wire (11), and a device (20) for stabilization being provided in the area (T) between the adjacent drying cylinders (10) and the leading roll (12) or equivalent placed as interlocked between them in the group of cylinders, from which device for stabilization an air flow (F) can be directed which is directed in the direction opposite to the direction of running (P_{11}) of the paper web (W). The nozzle opening (21) of the device (20) for stabilization is shaped so that said air flow (F) follows the substantially smooth face (22) of the device (20) for stabilization, which face (22) is substantially parallel to the drying wire (11), while, at the same time, ejecting surrounding air along with it, and that the group of cylinders has been formed as of compact geometry.

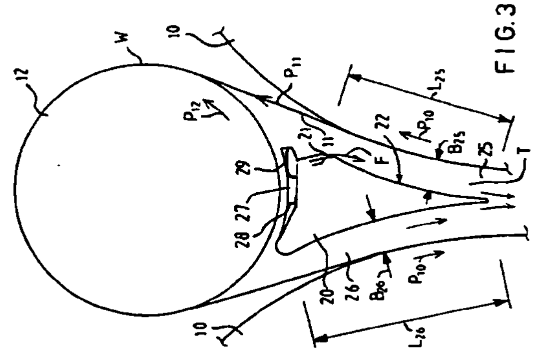

FIG.3

EP 0 566 552 A1

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The invention concerns a device for stabilization of the paper web in a group of cylinders in the dryer section of a paper machine, which group of cylinders comprises a row of drying cylinders and a corresponding row of leading rolls or equivalent placed as interlocked with said drying cylinders, said group of cylinders being provided with single-wire draw so that the heated drying cylinders in the group are placed outside their loop of the drying wire and the leading rolls in the group are placed inside the loop of the drying wire, and a device for stabilization being provided in the area between the adjacent drying cylinders and the leading roll or equivalent placed as interlocked between them in the group of cylinders, from which device for stabilization an air flow can be directed which is directed in the direction opposite to the direction of running of the paper web.

The prior-art dryer sections of paper machines comprise a number of drying cylinders, which are, as a rule, heated by means of steam. The paper web to be dried is pressed against the drying cylinders by means of the drying wire into direct drying contact. In prior art, in dryer sections, both twin-wire draw and single-wire draw are employed. Recently, the single-wire draw has become more common, because it provides the web to be dried with constant support and with a closed draw through the whole dryer section, without free draws of the web.

As a rule, such dryer sections with single-wire draw are in use in which the cylinders in the upper row are heated cylinders, being placed outside the loop of the drying wire, and the cylinders in the lower row are leading cylinders or rolls, which are provided with suction holes for promotion of the support contact between the web and the wire. When a number of the above cylinder groups with single-wire draw are employed as placed one after the other, it is a drawback that the web is dried unequalsidedly, i.e. more quickly at the side that is placed in direct contact with the heated cylinder face. Asymmetric drying of the web produces a number of drawbacks, for which reason, in recent years, such multi-cylinder dryers with single-wire draw have become more common in which so-called inverted cylinder groups are used, in which inverted groups the drying cylinders are placed in the lower row and the leading cylinders or rolls in the upper row.

However, in these inverted groups, a drawback has been created by the pumping of air by the wires, which pumping produces detrimental pressure on the free portion at the inlet side of the wire and in the closing wire nips. In the wedge spaces that form the inlet-side nip for the web and for the wire, a pressure tends to be induced. Corresponding opening nips produce detrimental negative pressure, because replacement air is sucked into said nips from the sides of the dryer section. Said in-flowing air attempts to penetrate in between the wire and the paper, thus separating the edge of the paper from the wire, which produces drawbacks, such as web breaks. In an inverted group, the negative pressure in said outlet nips is increased further by the so-called chimney effect, i.e. by the air flows that can rise unhindered out of said spaces upwards by the effect of gravity.

It is also known in prior art, in multi-cylinder dryers provided with single-wire draw, to place the drying cylinders and the leading rolls very close to one another so that a more compact and less spacious paper-machine dryer section with single-wire draw is obtained, which can be made both shorter in the machine direction and lower in the vertical direction, as compared with prior art. By means of this, economies are also obtained in the cost of the paper-machine hall. In such groups of compact geometry in dryers of paper machines, problems are caused by winding of the paper onto cylinders and rolls. This has the consequence that the distance between the drying cylinder and the leading roll must be sufficient for the passage of loose paper and in particular for the passage of paper clods. Such a safety distance is commonly about 50...100 mm. Also, the distance between the blow-boxes, stabilization tubes, and equivalent used in a dryer section, which are supposed to prevent effects detrimental to the support contact between the web and the drying wire, and the drying cylinder/leading roll must, out of the reason given above, be sufficient. The phenomena that interfere with the support contact between the web and the drying wire arise, for example, from the fact that the boundary-layer flows produce difference in pressure between the different sides of the drying wire. These problems and the solutions related to them have been discussed, for example, in the applicant's FI Patents Nos. 65,460 and 69,332.

The object of the present invention is to provide such a stabilization device / tube for use in the dryer section of a paper machine as is suitable for use in connection with single-wire draw and in particular in dryer groups with compact geometry. It is a further object of the invention to provide a stabilization tube that is particularly well suitable for use in a so-called inverted group.

In view of achieving the objectives stated above and those that will come out later, the stabilization device in accordance with the invention is mainly characterized in that the nozzle opening of the device for stabilization is shaped so that said air flow follows the substantially smooth face of the device for stabilization, which face is substantially parallel to the drying wire, while, at the same time, ejecting surrounding air along with it, and that the group of cylinders has been formed as of compact geometry.

The invention is based thereon that the pressure produced by the pumping by the drying wire in the nip is brought to such a level that the paper web is not separated from the drying wire. In the solution of the

invention, said change in the pressure level is produced so that its effect is adequate also across the safety distance. In other words, the distance between the drying cylinder and the leading roll as well as the distance of the stabilization tube from said cylinder and roll can be kept sufficiently large for the passage of loose paper and in particular of paper clods.

Typically, a device in accordance with the invention consists of a blow nozzle and of a plane face, which mostly complies with the shape of the drying cylinder. The blow direction of the blow nozzle is opposite to the running direction of the wire, and the nozzle is shaped so that the air that is blown starts following the plane face while, at the same time, ejecting surrounding air along with it. The passage formed by the drying cylinder and by the smooth face of the stabilization tube improves the result further. This passage is made as long as possible in order that the effect of stabilization could be extended over a sufficiently long distance. Also, at the opposite side of the stabilization tube, there may be a similar passage. Since, at the opposite side, the web runs away from the roll nip, the pumping produced by the wire produces a sufficient negative pressure in the passage, which negative pressure is increased further by the blowing out of the blow nozzle.

The device in accordance with the invention may also be installed closer to the wire, in which case the device operates as above, but the nozzle blowing is placed closer to the wire.

The sealing between the stabilization tube and the leading roll, which is often a suction roll, can be arranged, e.g., by means of an air nozzle or by means of a mechanical seal. If the above modes cannot be employed, it is possible to reduce the air leakage by means of various so-called labyrinth seals while keeping the distance between the pipe and the roll normal. The idea is to make the air follow a solid curved face and, thereupon, to collide against an obstacle. The more obstacles are available, the better is the result that is achieved, however, in consideration of the optimal length of one pair of obstacles. With a sealing like this, the capacity (negative pressure) can be increased by about 15 %.

When the device is installed close to the drying wire, it can also be constructed so that the entire area between the drying cylinder and the roll is closed and the blowing opposite to the wire is produced in the way described above, either by making use of the passage effect or without said effect. The negative pressure in the closed space can be increased by means of a blow nozzle parallel to the running direction of the wire and placed between the device of the opposite side and the wire or, more commonly, by making use of the pumping effect of the wire's own.

In the following, the invention will be described in more detail with reference to the figures in the accompanying drawing, the invention being, however, by no means, supposed to be strictly confined to the details of said illustrations.

Figure 1 is a schematic side view of a group of cylinders in the dryer section of a paper machine in which a stabilization device of the invention is applied.

Figure 1A is a schematic vertical sectional view in which the lateral plates employed in connection with the stabilization device of the invention are seen.

Figure 2 is a schematic vertical sectional view in the machine direction of an exemplifying embodiment of the stabilization device of the invention.

Figure 3 shows another exemplifying embodiment of the invention in a way corresponding to Fig. 2.

Figure 4 shows a further exemplifying embodiment of the invention in a way corresponding to Figs. 2 and 3.

Figure 5 shows a further exemplifying embodiment of the invention in a way corresponding to Figs. 2 and 3.

Fig. 1 illustrates an inverted cylinder group R_n in a dryer section of a paper machine, in which the drying cylinders 10, with which the web W to be dried enters in direct contact, are in the lower row and the leading rolls or cylinders 12 are in the upper row. In inverted groups R_n, single-wire draw is employed so that the drying wire 11, which is guided by the guide rolls 14, carries the web W to be dried meandering over the drying cylinders 10 and the leading rolls 12. The web W is brought into the group R_n from the preceding group R_{n-1} with single-wire draw, in which the drying cylinders 30 are placed in the upper row and the leading rolls 32 in the lower row, and the web W is transferred from the wire 31 over the guide roll 33 onto the wire 11 over the guide roll 13. After the inverted group R_n, the web W is transferred, after the guide roll 13, into the next non-inverted group R_{n+1} with single-wire draw, onto its drying wire 31.

The cylinders 10;30 in the dryer section are, for example, steam-heated, smooth-faced drying cylinders, against which the web W to be dried enters into direct contact as pressed by the drying wire 11;31. The leading rolls 12;32 are, for example, suction cylinders in themselves known, which are provided with a perforated mantle with a grooved outer face. By means of the negative pressure effective in the grooved face of the leading roll 12;32, the web W is kept reliably on the face of the drying wire 11;31 as the web runs over the leading roll 12;32 at the side of the outside curve over a sector larger than 180°. The leading rolls 12;32 may also be smooth, grooved) or perforated rolls.

The stabilization tubes 20;(40;50) shown in Fig. 1 close the inlet nips between the leading roll 12;32 and the drying cylinders 10, which nips are closed in the running direction of the web W, and said tubes eject air out of these nips so that a pressure interfering with

the support contact between the web W and the drying wire 11 is not formed in said nips.

Fig. 1 illustrates such a group in a paper-machine dryer section in which so-called compact geometry is applied, in which the diameter D_{10} of the drying cylinder 10 is 1200...2500 mm, preferably 1500...2500 mm, and the diameter of the leading roll 12 is 200...2000 mm, preferably 500...1500 mm. Thus, the ratio of the diameter D_{12} of the leading roll 12 to the diameter D_{10} of the drying cylinder 10 is 1:6...4:5, preferably 1:3...3:5. The minimum distance S_1 between the leading roll 12 and the drying cylinder 10 is 50...600 mm, preferably 75...300 mm, and the minimum distance S_2 between two drying cylinders 10 is 10...600 mm, preferably 150...500 mm. The minimum distance S_3 of the stabilization tube 20 from the leading roll 12 is 0...50 mm, preferably 10...30 mm, and the distance S_4 of the stabilization tube 20 from the drying cylinder 10 at the inlet side is 10...100 mm, preferably 15...75 mm, and the distance S_5 from the drying cylinder at the outlet side is 10...100 mm, preferably 20...80 mm.

Fig. 1A is a schematic vertical sectional view, in which the lateral plates 27 employed in connection with the stabilization device 20 in accordance with the invention are seen. Leakage flow taking place from both edges of the wire 11 can be reduced or prevented so that the space that remains between the leading roll 12 and the adjacent drying cylinders 10 and the wire 11 is closed by means of lateral plates 27, which are, for example, of a suitable plastic which does not damage the wire 11 or the web W even if contact took place. Further, if necessary, the lateral plates 27 are slightly rounded at their edges so as to prevent any detrimental effects of contacts that may take place with the wire 11 and with the web W. The lateral plates 27 are used in connection with all of the exemplifying embodiments of the invention that will be described in the following in the direction of width of the paper web W so as to close the space defined by the cylinders 10 and by the leading roll 12, whereby, with the aid of the stabilization device/tube 20, the drying cylinders 10, the leading roll 12, and the drying wire 11, the paper web W forms a closed space, in which the desired pressure level can be produced by means of nozzle blowing / pumping by the drying wire. In Fig. 1A, a closing wire nip is denoted with the reference A, and a corresponding opening nip with the reference B.

According to Figs. 1 and 1A, in the space between the leading rolls and the adjacent drying cylinders 10, stabilization tubes 20;(40;50) in accordance with the invention have been provided, whose construction and operation will be described in more detail with reference to the exemplifying embodiments shown in Figs. 2 to 5.

Fig. 2 illustrates an exemplifying embodiment carried into effect in a "normal" group R_{n-1},R_{n+1} in a dryer section, and Fig. 3 illustrates an exemplifying embodiment carried into effect in an inverted group R_n in a dryer section. In Figs. 2 and 3, the sense of rotation of the leading roll 12;32 is denoted with the arrow P_{12} and P_{32}, respectively, and the sense of rotation of the drying cylinders 10;30 with the arrow P_{10} and P_{30}, respectively. The running direction of the drying wire 11;31 and, thus, also of the web W is denoted with the arrow P_{11} and P_{31}, respectively. The stabilization tube 20 has a box construction and extends in the transverse direction across the entire width of the paper web W. As regards its cross-sectional shape, the stabilization tube 20 is triangular and complies with the shape of the area T that remains between the drying cylinders 10 and the leading roll 12. The stabilization tube 20 communicates with an air pipe (not shown), through which dry air of suitable temperature is introduced into the stabilization tube 20, which air is blown out of the opening 21 in the stabilization tube 20 as an air flow F in the direction opposite to the running direction of the adjacent web W. The nozzle opening 21, whose diameter is 0.5...5 mm, preferably 1...3 mm, has been shaped so that the air flow F starts following the smooth face 22 of the stabilization tube 20 while, at the same time, ejecting surrounding air along with it. The shape of the smooth face 22 of the stabilization tube 20 complies with the shape of the adjacent drying cylinder 10 and of the drying wire 11, i.e. the curve form, being substantially parallel to said faces. In this way, a passage 25 is formed between the smooth face 22 of the stabilization tube 20 and the adjacent drying cylinder 10 and drying wire 11. The passage 25 formed by the drying cylinder 10;30 and by the smooth face 22 of the stabilization tube 20 improves the result. The width B_{25} of the passage 25 is 10...100 mm, preferably 20...80 mm. In view of obtaining the best stabilization result, the passage 25 is formed as long as possible, and its length L_5 is 100...600 mm, preferably 200...500 mm. Also, at the opposite side of the stabilization tube 20, there may be a passage 26 of corresponding type, whose length L_{26} is 50...600 mm, preferably 100...500 mm, and width B_{26} 5...100 mm, preferably 20...80 mm. At this opposite side, the drying wire 11;31 and the web W run away from the roll nip, in which case the pumping effect produced by the drying wire 11; 31 produces a negative pressure in the passage 26. The air flow F also increases the negative pressure in the opposite opening nip, i.e. in the outlet nip.

The sealing between the stabilization tube 20 and the leading roll 12;32 can be carried out, e.g., by means of an air nozzle or a mechanical seal (not shown in the figure). Leakage air can also be reduced by means of a so-called labyrinth seal, in which case the distance between the stabilization tube 20 and the leading roll 12 can be kept normal, about 15...20 mm. The idea of a labyrinth seal construction 27 is to

make the air flow F_L follow a fixed curved face and, hereupon, to collide against an obstacle 28;29. The more obstacles 28;29 can be prepared, the better is the result that is obtained. It is, however, necessary to take into account the optimal length L_{27} of one pair of obstacles 28;29, which length is 50...300 mm, preferably 100...200 mm. In this way, the sealing is improved by about 15 % as compared with a solution in which no labyrinth-seal construction 27 is used.

The exemplifying embodiment of the invention as shown in Fig. 4 operates, in principle, in the way illustrated above in Figs. 2 and 3, and the same reference numerals have been used for equivalent parts. The stabilization device 40 of box construction, which extends substantially across the entire width of the web W at its edges, has been installed close to the drying wire 11. The air flow F coming out of the nozzle opening of the stabilization tube/device 40 starts following the smooth face 42 of the stabilization device 40. The distance B_{45} between the wire 11 and the stabilization device 40 in the passage 45 at the level of the nozzle opening 41 is 10...50 mm, preferably 15...25 mm, and in the passage 46 the distance B_{46} is 5...50 mm, preferably 10...30 mm. The length L_{45} of the passage 45 is 50...300 mm, preferably 100...200 mm. According to Fig. 4, the area between the drying cylinders 10 is closed by means of the stabilization tube 40, and in the direction of width of the paper web W, the space defined by the cylinders 10 and by the leading roll 12 is closed at its ends by means of lateral plates 47. The stabilization tube 40, the drying cylinders 10, the leading roll 12, and the drying wire 11 / paper web W form a closed space, in which the desired pressure level can be produced by means of nozzle blowing / pumping by the wire. In Fig. 4, the solid line illustrates an exemplifying embodiment in which no passage has been formed between the drying cylinder 10 and the stabilization tube 40 at the side of the nozzle opening 41, and the dashed line shows an embodiment with a passage 45. The passage formed between the other side of the stabilization device/tube 40 and the adjacent drying wire 11 on the drying cylinder 10 is denoted with the reference numeral 46.

In the exemplifying embodiment of the invention shown in Fig. 5, whose main principles are similar to those illustrated in Figs. 2 to 4 and in which the same reference numerals have been used for equivalent parts, the stabilization tube 50 has also been placed close to the wire 11, and the distance S_{55} between the nozzle opening 51 of the stabilization tube 50 and the drying wire is about 10...50 mm. The stabilization device 50 operates in the way described above in relation to Figs. 2 to 4, but, thus, the nozzle blowing and the air flow F have been fitted closer to the wire 11. The stabilization device 50 has a box construction and extends across the entire width of the web W. The length L_{55} of the passage 55 is 50...500 mm, preferably 150...400 mm, and the width B_{55} is 30...100 mm, preferably 50...75 mm.

In the following, the patent claims will be given, and the various details of the invention may show variation within the scope of the inventive idea defined in said claims and differ from the details stated above for the sake of example only.

Claims

1. Device (20,40,50) for stabilization of the paper web in a group of cylinders (R_{n-1}, R_n, R_{n+1}) in the dryer section of a paper machine, which group of cylinders (R_{n-1}, R_n, R_{n+1}) comprises a row of drying cylinders (10,30) and a corresponding row of leading rolls (12,32) or equivalent placed as interlocked with said drying cylinders, said group of cylinders (R_{n-1}, R_n, R_{n+1}) being provided with single-wire draw (11,31) so that the heated drying cylinders (10,30) in the group are placed outside their loop of the drying wire (11,31) and the leading rolls (12,32) in the group are placed inside the loop of the drying wire (11,31), and a device (20,40,50) for stabilization being provided in the area (T) between the adjacent drying cylinders (10,30) and the leading roll (12,32) or equivalent placed as interlocked between them in the group of cylinders, from which device for stabilization an air flow (F) can be directed which is directed in the direction opposite to the direction of running (P_{11},P_{31}) of the paper web (W), **characterized** in that the nozzle opening (21,41,51) of the device (20,40,50) for stabilization is shaped so that said air flow (F) follows the substantially smooth face (22,42,52) of the device (20,40,50) for stabilization, which face (22,42,52) is substantially parallel to the drying wire (11,31), while, at the same time, ejecting surrounding air along with it, and that the group of cylinders (R_{n-1}, R_n, R_{n+1}) has been formed as of compact geometry.

2. Device as claimed in claim 1, **characterized** in that the minimum distance (S_2) between two adjacent drying cylinders (10,30) in the group of cylinders (R_{n-1}, R_n, R_{n+1}) is 100...600 mm, preferably 150...500 mm, and that the minimum distance (S_1) between the drying cylinder (10,30) and the leading roll (12,32) or equivalent is 50...600 mm, preferably 75...300 mm.

3. Device as claimed in claim 1 or 2, **characterized** in that the ratio of the diameter (D_{12}) of the leading roll (12,32) or equivalent to the diameter (D_{10}) of the drying cylinder (10,30) is 1:6...4:5, preferably 1:3...3:5.

4. Device as claimed in any of the claims 1 to 3,

characterized in that a passage (25,45,55) has been formed between the drying cylinder (10,30) and the substantially smooth face (22,42,52) of the stabilization device (20,40,50), the air flow (F) being fitted to flow in said passage.

5. Device as claimed in claim 4, **characterized** in that the length (L_{25},L_{45}, L_{55}) of the passage (25,45,55) is 50...500 mm, preferably 100...400 mm, and that the width (B_{25},B_{45},B_{55}) of the passage (25,45,55) is 10...100 mm, preferably 15...75 mm.

6. Device as claimed in any of the claims 1 to 5, **characterized** in that the gap between the stabilization device (20) and the leading roll (12) is sealed (27).

7. Device as claimed in any of the claims 1 to 6, **characterized** in that the gap between the stabilization device (20) and the leading roll (12) is sealed by means of a labyrinth seal (27), which comprises at least one pair of obstacles (28,29).

8. Device as claimed in any of the claims 1 to 7, **characterized** in that the length (L_{27}) of the pair of obstacles (28;29) in the labyrinth seal (27) is 50...300 mm, preferably 100...200 mm.

9. Device as claimed in any of the claims 1 to 8, **characterized** in that the cross-sectional shape of the stabilization device (20,40) complies with the shape of the area between the drying cylinders (10,30) and the leading roll (12,32) so that a safety distance remains at each edge.

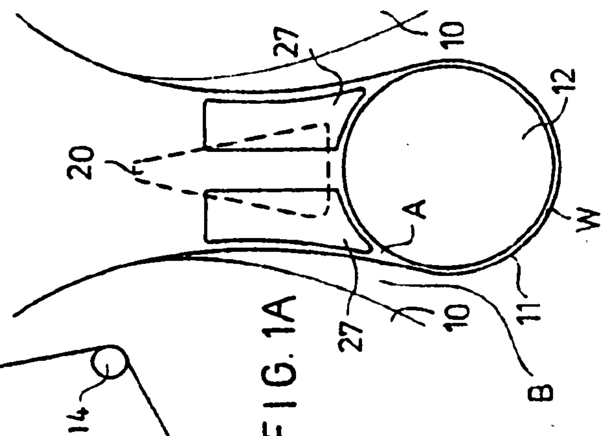
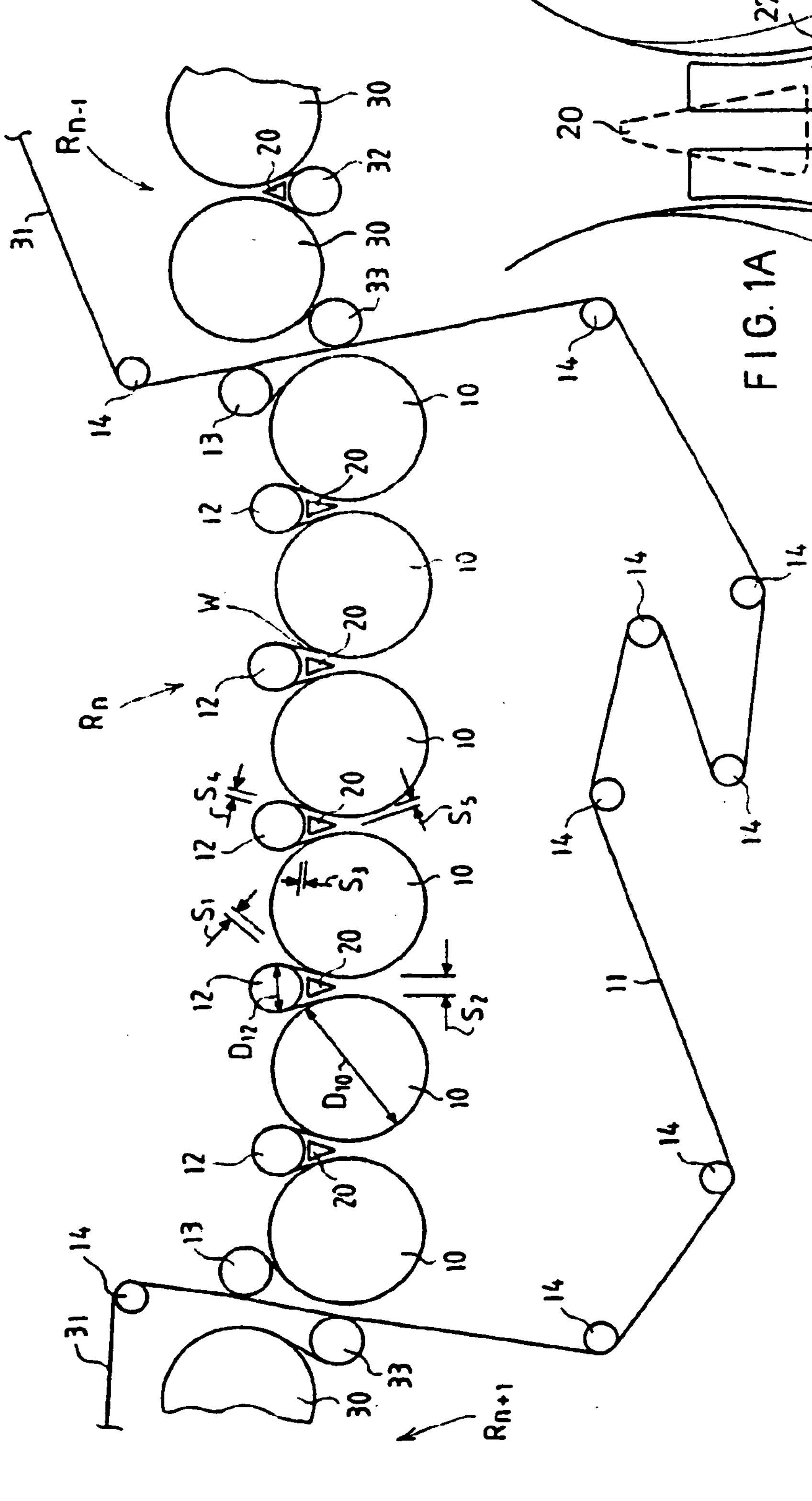

10
27
12
20
A
W
27
10
11
B

FIG.1A


R_{n-1}
31
30
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32
30
33
14
13
10
12
W
R_n
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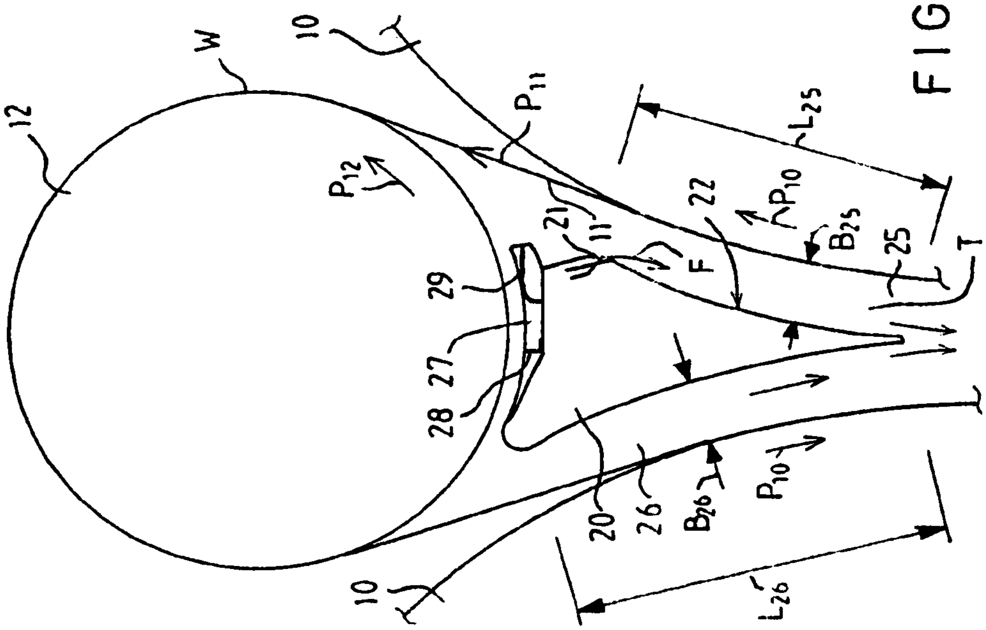
S_5
S_1
S_3
S_2
D_{12}
D_{10}
11
R_{n+1}

FIG.1


12
W
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P11
P12
22
P10
21
11
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B25
25
L25
T
29
27
28
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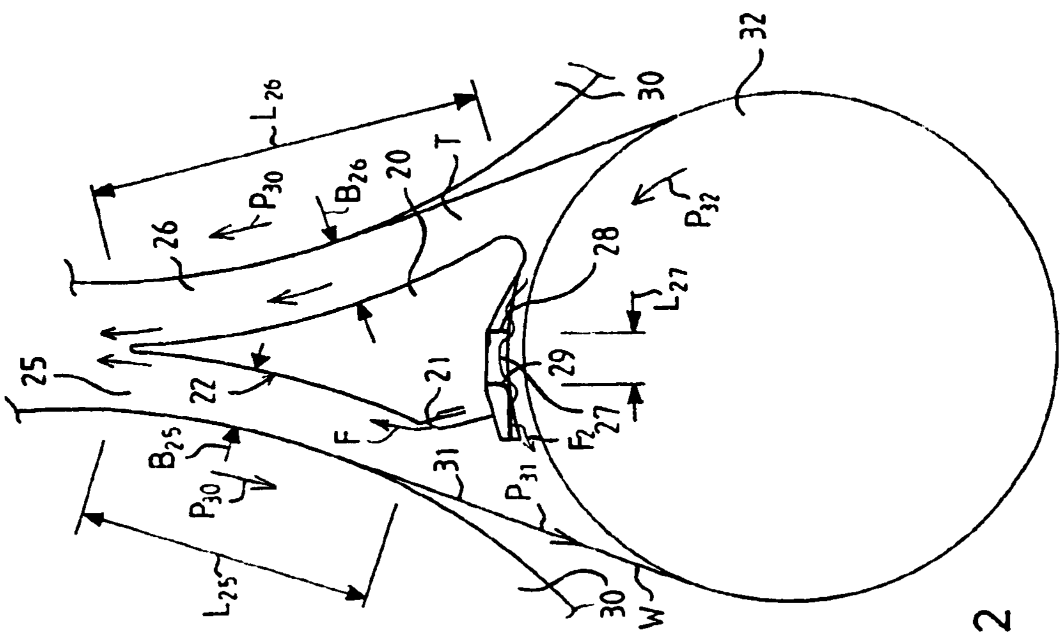
P10
10
L26

FIG.3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L25
30
W

FIG.2

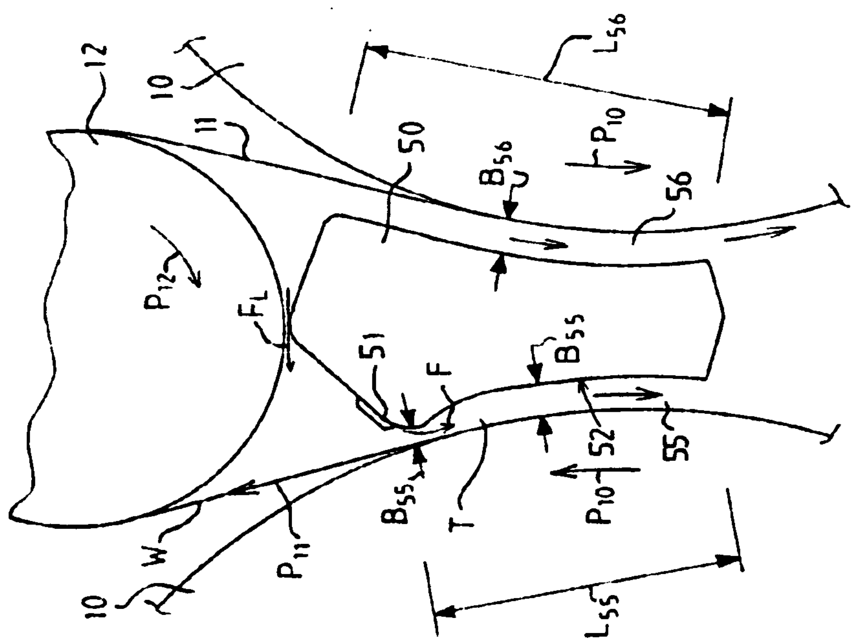

FIG. 5

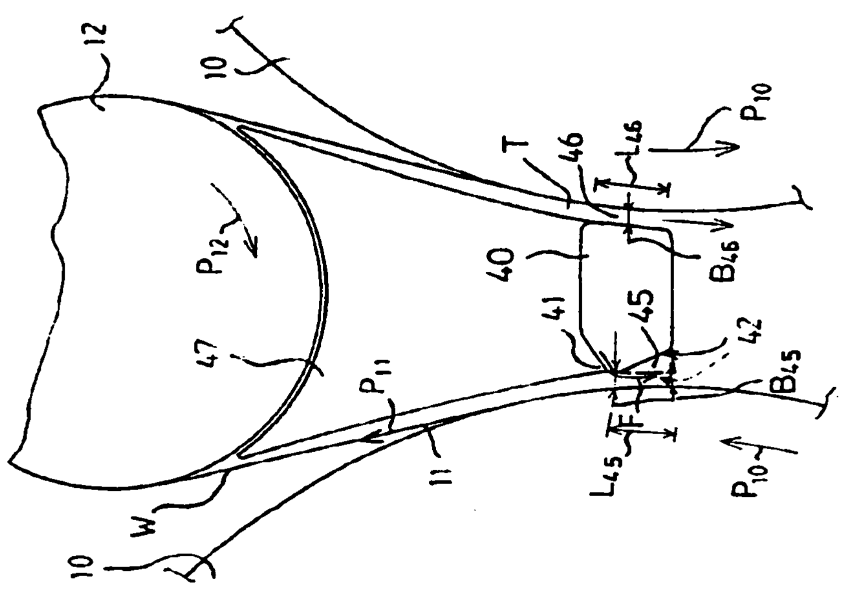

FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 85 0075

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-A-3 538 623 (MASCHINENFABRIK ANDRITZ) * the whole document *	1,6	D21F5/04
X	WO-A-8 901 073 (BELOIT) * the whole document *	1,9	
Y	DE-A-3 818 600 (VALMET PAPER MACHINERY) * the whole document *	1,3-6,9	
Y	DE-A-3 828 743 (VALMET PAPER MACHINERY) * the whole document *	1,3-6,9	
A	EP-A-0 415 900 (VALMET PAPER MACHINERY) * the whole document *	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			D21F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 AUGUST 1993	DE RIJCK F.

CATEGORY OF CITED DOCUMENTS

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